SWIMMING POOLS AND OTHER PUBLIC BATHING PLACES*

STANDARDS FOR DESIGN, CONSTRUCTION, EQUIPMENT, AND OPERATION

DURING the past six years separate Committees on Bathing Places of the Public Health Engineering Section of the American Public Health Association and of the Conference of State Sanitary Engineers have been very largely identical in personnel, and have worked practically as a single body making separate though similar reports each year to both organizations. At the meetings of both organizations in 1925 it was voted to unite these two separate committees into a joint committee representing both bodies.

At the time when these committees were instituted the practice as to construction, equipment and operation of swimming pools varied widely in different states and in different communities within the state. Furthermore, although it was beginning to be recognized that certain diseases might be spread through the medium of improperly conducted public bathing places, the control measures necessary to insure proper cleanliness and sanitation had not been formulated.

In previous reports the committee has presented certain evidence as to the causation of various transmissible diseases by the waters of poorly constructed and equipped or improperly operated swimming pools, by bathing in polluted waters and by the use of incompletely sterilized bathing suits and towels, and the need of improved bathing place sanitation

throughout the country. In the 1923 reports the committees proposed certain tentative standards for the physical, chemical, and bacterial quality of swimming pool waters together with certain operating regulations for the maintenance of those standards. In the 1925 reports the committees presented information as to the measures necessary for the safety of bathers and for the prevention of accidents.

During recent years there has been a widespread demand that the committee correlate the data included in its reports with other unpublished information which has accumulated in its files and formulate a standard code of bathing place sanitation. In compliance with this demand the report of the joint committee to the conference of State Sanitary Engineers in May, 1926, proposed a rather complete code of standards for the design, construction and equipment of swimming pools together with certain standards for other bathing places. With certain minor changes which have seemed advisable following discussion at the conference and from the comments received from swimming pool designers, makers of swimming pool equipment, and others, and with the incorporation of the tentative standards of water quality, etc., presented in the 1923 report of your Committee on Bathing Places, we now offer the appended code of Standards for the Design, Construction, Equipment, and Operation of Swimming Pools and Other Public Bathing Places, for the consideration of this section.

^{*} Report of the Joint Committee on Bathing Places of the A. P. H. A. and the Conference of State Sanitary Engineers, presented to the Public Health Engineering Section of the American Public Health Association at the Fifty-fifth Annual Meeting, at Buffalo, N. Y., October 12, 1926.

RECOMMENDATIONS

In accordance with the usual procedure in the preparation and adoption of standards, the committee would recommend:

1. That the appended standard code be approved in principle as a whole by this section.

- 2. That these standards be referred back to the Committee on Bathing Places for such minor correction and revision as may be advisable.
- 3. That the committee be instructed to present a final report on standards for adoption at the next meeting of this section.

STANDARDS FOR DESIGN, EQUIPMENT, AND OPERATION

I. Classification of Bathing Places

A. The term "bathing place" as used in this report includes all bodies of water sufficiently deep for complete immersion of the body and used collectively by numbers of persons for swimming or recreative bathing, together with the shores, buildings, equipment, and appurtenances pertaining to such bathing places. It does not include public or semi-public baths, where the main object is the cleansing of the body or the practice of the healing art, unless such baths contain pools or tanks used collectively by a number of individuals.

- B. Bathing places may be divided into three classes:
 - 1. Natural outdoor ponds, rivers, tidal waters, etc.
 - 2. Outdoor pools which are partly artificial and partly natural in character
 - 3. Pools outdoor or indoor which are entirely of artificial construction

Natural ponds and rivers are necessarily dependent upon natural flow or upon wind and wave action for circulation of the water. Artificial and partly artificial pools may be divided into four classes according to the method by which water cleanliness is obtained.

- a. Large semi-artificial pools in which the water cleanliness is maintained by natural flow or circulation.
- b. Fill and draw pools where cleanliness of water is maintained by complete removal and replacement of the water at periodic intervals.
- c. Flowing through pools where cleanliness is maintained by circulation of water through the pool from some natural or

- artificial source, but where the outflowing water is wasted.
- d. Recirculation pools in which circulation of the water is maintained through the pool by pumps, the water drawn from the pool being clarified by filtration before being returned.

II. General Principles of Bathing Place Sanitation

A. In the control of swimming pool and bathing place sanitation certain broad principles apply to all classes of public bathing places.

B. The committee is of the opinion that all public bathing places both natural and artificial should be under the sanitary control of the public health authorities.

- C. In the opinion of the committee the same standards of cleanliness and bacterial purity of the water and the same precautions against the possible spread of disease should apply at both indoor and outdoor swimming pools.
- D. The requirements should be the same for all artificial and semi-artificial pools whether located indoors or outdoors, so far as the features of design and equipment apply to maintenance of cleanliness of the pool and of the water with which it is filled.
- E. At public bathing beaches on natural waters the same sanitary standards should apply to bathing houses, dressing rooms, toilet facilities, and to the handling and care of bathing suits, towels and other articles of bathing apparel as would be required at artificial swimming pools.
- F. Sanitary drinking fountains with a supply of pure water should be installed at all bathing places. The common use

of towels, drinking cups, combs, hair brushes, or other toilet articles should be strictly prohibited.

III. Bathing Beaches

A. It is very desirable that the bathing waters at public bathing places on natural streams, lakes and tidal waters should be of the same standard of bacterial quality as is required for swimming pools. It is also desirable that the same standard of cleanliness be applied, although it may at times be necessary to sanction public bathing in waters which contain more turbidity and color than would be permissible in an artificial pool.

B. In the selection of a natural bathing beach a careful study should be made of the possibility of pollution by sewage, giving due regard to natural currents, wind action, and similar factors. Attention should also be paid to the possibility of fouling of the waters and beach by algae or by aquatic plants growing on the bottom or washed in from outside.

C. The shore and bottom at a natural beach should be of sand with no sudden slope or holes up to a water depth of six feet. There should also be no swift treacherous currents or submerged rocks or other dangerous obstructions within the bathing area.

D. In a number of instances disinfection of waters at natural bathing beaches has been carried out with considerable success. At Washington some years ago the waters of the so-called tidal basin were treated with liquid chlorine applied from a boat, and this procedure has since been used at other places. At Detroit, in 1925, the waters of the river were treated with liquid chlorine from a perforated pipe laid in the bottom of the river a short distance above the public bathing beach. The results of both these methods of safeguarding bathing have been reasonably satisfactory. The amounts of chlorine to be used in treatment of natural bathing waters should be governed by the same requirements as defined in the committee standards for artificial pools.

IV. Location and Layout of Pools

A. The location of an outdoor pool will be governed largely by local conditions; and arrangement of dressing rooms, etc., can be made to conform to the sanitary requirements. In locating an indoor pool careful study must be given to architectural and engineering features in order that the proper layout may be obtained.

B. The layout or arrangement of entrances and exits of the pool room in relation to dressing rooms, showers and toilets must be such as to enforce proper routing of bathers. Coming from the dressing room a bather should be required to pass the toilets, and go through the shower room before arriving at the pool entrance. Bathers should leave the pool through a separate exit leading to toilets and dressing rooms.

C. At pools used simultaneously by both sexes separate entrances and exits should be provided for men and women. There should be no connection between men's and women's quarters.

D. Entrances and exits must be located at shallow water portion of the pool.

E. If pool is to be of recirculation type, ample room must be provided for filters and other units. All recirculation piping, inlet and outlet valves, etc., must be located where they will be readily accessible.

F. At indoor pools where liquid chlorine disinfection is to be used, it is recommended that the chlorine apparatus be located in a glass enclosure in the pool room in order that dosage may be under the immediate supervision of the pool attendant.

V. Design and Construction Features

A. Material: Any material which will provide a tight tank with smooth and easily cleaned surfaces may be used for artificial swimming pools.

B. Details of Design: The details of design in so far as they relate to strength of material, water-proofing, etc., are essentially the same as in design of other

tanks of similar size and shape and are, therefore, omitted from this report.

In the design of a new pool provision should always be made for complete circulation of water through all parts of the pool during the bathing period. Without proper circulation it is difficult or impossible to maintain good sanitary conditions at all times, even though the pool be completely emptied, cleaned, and refilled each day. The installation of new fill and draw pools cannot be recommended.

C. Shape: Indoor pools should be of rectangular shape with deep water at or near one end and shallow water at the other. Small outdoor pools should be of same general design as indoor pools. The best shape for large outdoor pools depends largely on the size and on local conditions. It is considered better practice to build large pools with the deep water area in the center.

D. Dimensions: For swimming records a straight away course of at least 60 feet with 5 foot lanes is required. Length of pool should be not less than 60 feet and width should be some multiple of 5 feet. The area to be provided for the expected bathing load is discussed in a subsequent chapter.

E. Depth of Water: The minimum depth of water in the deep portion of any public pool should be not less than 6 feet.

F. Proportion Deep and Shallow: Some authorities recommend that the area of shallow water, 5 feet or less in depth, should be 80 per cent or more of the total area of large outdoor pools. Such proportioning must be considered in relation to the pool volume, the bathing load, the recirculation or flowing through purification system, etc. The committee has insufficient information on this point to warrant any recommendation at the present time.

G. Slope of Bottom: The slope of the bottom of any part of a pool where the water is less than 6 feet deep must not be more than 1 foot in each 15 feet. There should be no sudden changes of slope

within the area where water depth is less than 6 feet.

H. Side Walls: The side and end walls of all artificial and semi-artificial pools should be vertical. Sloping side walls are dangerous and cannot easily be kept clean.

I. Pool Lining: Including bottom and sides up to runaways lining must be of white or light color material and present a smooth finished surface without cracks or joints. All corners must be rounded. Tile or glazed brick lining is recommended for all indoor pools and for small outdoor pools. White cement smoothly finished is satisfactory for large outdoor pools. Dirt does not show on asphalt or other similar dark material and such materials are not suitable for pool lining. The use of paint or similar material to obtain a light colored finish is not satisfactory and should not be permitted. Sand or earth bottoms cannot be kept clean and are not recommended for pools.

J. Markings: It is recommended that swimming lanes be marked on the bottom with dark colored material of the same kind as pool lining. The outlet of the pool should also be plainly marked by a black or dark colored circle, unless outlet grating is of conspicuous coloring. depth of water at the deepest point and at the 5-foot point should be conspicuously marked on both sides of a pool with deep water at one end. Markings showing depths in 1-foot increments are desirable. In large pools with deep water only in the middle the 3- and 5-foot depth line should be conspicuously marked on the bottom and also designated by surface floats.

VI. Proportioning Pool Area to Expected Load

A. In the design of an artificial pool due allowance must be made for the number of bathers who may be expected at the time of maximum use. In computing the area which must be provided it is recommended that the pool be divided into three zones, and the area of each computed separately.

B. From the data collected by the committee for its fifth report it was the consensus of opinion that an area extending 10 feet from the extremity of a diving board or tower should be considered as reserved for divers, and that not more than two or three persons should be permitted in the water in this area at one time while diving is in progress. About three times that number will be on the shore or diving platform awaiting their turn to dive. Twelve persons is therefore the maximum number which may be permitted for the area within 10-foot radius of each diving board or platform.

C. It was the consensus of opinion of swimming pool operators that the space required by a swimmer might fairly be expressed as five-fourths the square of his height and that on an average two-thirds of the swimmers present would be in the pool at the same time. On this basis the average space requirement for an adult swimmer is 36 square feet and allowing for one-third of swimmers on the shore, an average of 27 square feet should be provided for each swimmer who may be expected to be present at time of maximum load.

D. In computing the area to be provided for persons who do not swim we must take into consideration the character of the pool. At indoor pools and small outdoor pools this area should probably be included with the swimming area and the crowding limit computed as At large outdoor pools where a considerable proportion of the water is shallow water, we may assume that 50 per cent of the non-swimmers would be on shore. The average space allowance for each non-swimmer in the water is approximately one-half that of the swimmer in deep water. Combining these factors an allowance of 10 square feet per bather should be allowed for this portion of the pool.

VII. Inlets and Outlets

A. All pools should be provided with an outlet at the deepest point of sufficient

size to permit the pool to be completely drained in four hours or less. Outlet opening in the floor of the pool should be at least four times the area of the discharge pipe to reduce suction currents. This opening must be covered with a proper grating.

B. In rectangular pools with deep water at or near one end, multiple outlets should be provided where the width of the pool is more than 20 feet. In such cases outlets should be spaced not more than 20 feet apart, nor more than 10 feet from side walls.

C. Proper pipe connections must be provided in recirculation pools to permit water being drained directly to the sewer, as well as to recirculation pumps. In making connections of pool outlets with sewers proper care must be taken to prevent any possibility of sewage from the building or from outside backing up into the pool.

D. Inlets for fresh or re-purified water should be located to produce as far as possible a uniform circulation of water throughout the entire pool. In semi-artificial pools of irregular shape a careful study should be made of probable circulation currents and inlets located and spaced to provide as complete circulation as possible. All inlets should be located at the shallow water portion of the pool and not more than 1 foot below water line, except in case where reverse circulation is used as discussed in paragraph H.

E. Where the distance across the shallow portion of the pool is more than 20 feet, multiple inlets must be provided, so spaced that each inlet will serve a linear distance of not more than 20 feet. At spoon shaped rectangular pools where the outlets are located more than 5 feet from the end wall, inlets should be placed at both ends of the pool. At large pools with outlets near the center, inlets should be placed at the specified intervals entirely around the perimeter of the pool.

F. In small rectangular pools with only a single inlet and a single outlet, inlet and outlet should be located on a line

drawn lengthwise through the center of the pool. Inlet orifices located at or below normal water level should be covered with a grating having openings of at least twice the orifice area.

G. Each inlet should be designed as an orifice and proportioned to supply the volume of water required at that particular point to obtain the best circulation. Inlet piping should be designed to provide at least twice the area of the inlet orifice. In large pools the inlet pipe system should be designed in sections with gates to permit regulation of the flow to different inlet orifices.

H. In a few cases pools have been designed for fresh water or re-purified water to enter at the deep point and overflow through outlets or scum gutters in the shallow portion. It is believed there may be some advantage in having flow through the pool in this direction, thus permitting floating matters and dirtier waters from the more crowded shallow area to be carried off more rapidly. The committee suggests that in designing piping systems for recirculation or flowing through pools, cross connections be provided so that flow through the pool may be in the direction which experiments may prove most desirable. It is also suggested that the question of having scum gutters serve as overflows and outlets in recirculation or flowing through systems be studied more carefully, as it appears that such design may have certain material advantages.

VIII. Scum Gutters

A. Scum gutters should extend completely around the pool. The design of scum gutters should be such that matters entering them will not be washed out by a sudden surge of entering water, and that danger of bathers catching arms or feet in them be reduced to a minimum. The edge of a scum gutter should be designed to serve as a hand hold for bathers. Gutters should, therefore, be sufficiently deep that bathers' fingers will not reach to the bottom. Sufficient open-

ing must be provided to permit mechanical cleaning of the gutters.

B. Drainage outlets should be provided at least every 10 feet and the gutter bottom should pitch slightly to these outlets. Outlets and outlet pipes should be of generous size to permit rapid carrying away of water during surface flushing or reversed flow. Drainage from scum gutters may be conducted directly to sewers or to suction of recirculating pumps. Both such connections are advised.

C. All scum gutters should be recessed into the pool wall. There is no legitimate objection to having scum gutters project slightly into the pool to permit drainage from runways to flow directly over the edge of the pool into them. Such projection should not, however, be more than 2 inches.

IX. Steps, Ladders and Step Holes

A. Steps or stairways for entering and leaving the pool should be of such construction as to minimize danger of accidents. Ladders or stairways should be located at one or both sides of the deep end of the pool. If the distance from the bottom of the pool to runway is more than 2 feet, a ladder or steps should also be placed at the shallow end of the pool. Treads of ladders or steps should be of non-slip material.

B. In some pools ladders have been replaced by step holes inserted in the pool wall. If step holes are provided, they should be of such design that they may be readily cleaned and be provided with drains into the pool to prevent accumulation of dirt.

C. Stairs, ladders, or step holes should have a hand rail on either side at the top leading out over the runway. Stairs should not project into the pool. If stairs are desired, the stairway should be recessed into the wall and the runway of the pool.

X. Runways or Sidewalks

A. Runways not less than 4 feet wide should extend entirely around the pool.

Runway floors should have a slope of about ½ inch to the foot, should be smooth and easily cleaned, but should be as far as possible of non-slip construction. The edge of the pool runway must be of non-slip construction for a width of at least 1 foot. The edge of the pool at its junction with the runways should be rounded. At indoor pools, unless runways are very wide, handrails on the outside wall are desirable.

B. The older practice was to require runways of all pools to slope away from the pool with drainage vents at intervals connecting with the sewer. Such a requirement seems unnecessary for indoor pools. The water carried out on runway is of the same character as that in the pool. Modern trend of opinion is toward having runways of indoor pools slope toward the pool with drainage into scum gutter or scum gutter drainage system. At outdoor pools so located that much dirt is blown in from outside it is desirable to have the runways slope away from pool to permit flushing such dirt directly to the sewers.

C. Some sanitary authorities also require a raised edge 2 inches or more in height between the pool and runways. Such a raised edge may lead to accidents by bathers tripping thereon and cannot be recommended for indoor pools. At outdoor pools a raised edge forms a barrier between pool and runway and permits the use of greater hose pressure for flushing. If installed for this purpose, such an edge should be not less than 1 foot wide and at least 6 inches high in order that danger of accidental tripping may be reduced as much as possible.

D. High, tight walls should encircle the pool outside the runways. Some outdoor pools have been constructed with areas of sand or grass and shrubbery just outside the runways. This practice is objectionable as it leads to tracking of much dirt into the pool. Trees and shrubbery overhanging or adjacent to the pool or runways are also objectionable and may cause unnecessary dirt in the pool.

XI. Visitors' Galleries

There must be an absolute separation of the space used by spectators and that used by bathers. There should be no means by which bathers can enter space reserved for spectators or vice versa. Visitors' quarters must have a separate entrance. Galleries for spectators should not overhang any portion of the pool surface. Floor and foot rail of the gallery should be of tight construction to prevent dirt tracked in from getting into the pool. Gallery floor should slope to a drain and should be flushed down with hose regu-Seats in galleries should be of non-absorbent construction to permit washing.

XII. Dressing Rooms

A. Bath houses to be used simultaneously by both men and women should have two parts, one for each sex, entirely separated by tight partitions.

B. Floors of all dressing rooms and locker rooms should be of smooth finished material, impervious to moisture, with no open cracks or joints. All floors should have a pitch of about ½ inch to the foot and should slope to a proper drain to permit washing down with a hose. All junction of the floors with side walls and partitions should be finished with rounded joints.

C. Walls and partitions of all dressing rooms and locker rooms should be of smooth, impervious material, without open cracks or joints. If walls of wood or similar material are used, all cracks and joints should be filled and the surface kept finished with paint or other sanitary waterproof coating. Partitions between dressing compartments should terminate not less than 4 inches above the floor to permit flushing of the entire floor area.

D. All furniture used in dressing rooms should be of simple character and of easily washable material. Lockers where provided should be of vermin proof construction with tight joints. All lockers should be properly ventilated.

E. All dressing rooms and appurtenances must be kept clean at all times. The use of a vermifuge spray for lockers and of a disinfectant on floors, walls and seats at frequent intervals is recommended. Foot tubs in dressing rooms at beach houses should be prohibited.

XIII. Showers, Toilets, Lavatories

- A. Adequate shower bath facilities with hot and cold water must be provided at all artificial pools. The minimum number of showers provided should be in the proportion of one for each 40 bathers expected at time of maximum load. At pools where mixed bathing is permitted it can usually be assumed that two-thirds of bathers at time of maximum load will be men.
- B. Shower baths should be of such design that a proper mixture of hot and cold water may be obtained without danger of scalding the bather. A Bidet or upward flow spray beneath each shower to permit washing between the legs is desirable.
- C. A foot trough with running water is desirable at entrance to outdoor pools and to beach bath houses. At certain pools operated in conjunction with surf bathing, it has been found advisable to make a wading pool of the entrance passage with automatic or continuous flow showers overhead, through which all bathers must pass on return to the pool.
- D. At public bathing beaches a sufficient number of showers should be provided to permit all bathers to rinse off sand and dirt before entering the dressing rooms.
- E. Adequate and proper toilet facilities for each sex must be provided at all pools and beach bath houses. The minimum number should be one toilet for each 40 women and one toilet and one urinal for each 60 men. Urinals should be of a type that will not cause splashing of urine upon legs and feet of bathers.
- F. Water flush toilets should be used wherever possible. Chemical closets may be used if proper sewage disposal is lacking. All closets and urinals must be prop-

erly serviced. Privies of any type are not recommended for public bathing places.

G. Lavatories located adjacent to toilets should be provided at all swimming pools in the proportion of one bowl to each 60 persons using the pool at time of maximum load.

XIV. Lighting, Ventilation, Heating

- A. A complete system of artificial lighting must be provided for all pools, bathing beaches, bath houses and dressing rooms which are to be used at night.
- B. Lighting fixtures must be of such number and design as to light all parts of the swimming pool and the water therein.
- C. Arrangement and design of lights must be such that life guards may see clearly every part of the bathing waters at a beach or pool, and all spring boards, towers, floats, and other appurtenances, without being blinded by the light.
- D. Indoor pools should be so located that they may be lighted during the day by windows on at least one side or by skylight. The window or skylight area should not be less than one-half the area of the pool including the runways.
- E. All indoor pools and all bath houses, dressing rooms, shower rooms and toilets at both indoor and outdoor pools and beaches, must be properly ventilated. Ventilation of indoor pool rooms must be so designed that direct draft will not blow on bathers.
- F. At all indoor pools except those so located that outside temperature never falls below 60° F. the pool room and all dressing rooms, shower rooms and toilets should be artificially heated to a temperature of between 70° F. and 75° F. Thermostatic control of the temperature of the air in the pool room and of the water in the pool is desirable.

XV. Recirculation System

A. The System: The recirculation system consists of the pumps, haircatcher, and filters together with all necessary pipe connections to the inlets and outlets of the pool. The water heater, the chlorin-

ator and the suction cleaner are also usually installed on or connected with the recirculation system and may be considered as integral parts thereof. This entire system and all its component parts should be designed to provide the required volume of recirculation water as specified in section XVI, G, with a minimum of frictional resistance. Filtration and disinfection are discussed separately in subsequent chapters. The requirements for other parts of this system are as follows:

B. Pumps: Centrifugal pumps are preferable for swimming pool circulation, although plunger pumps are sometimes Electric drive is also preferable. When pipe lines from suction cleaner lead to pump suction, a pump which will develop good vacuum must be used. When pressure filters are used pumps must be designed to pass the required volume under the maximum head which may develop in the filters. When designed to operate with multiple unit filters it is advisable to have pumps in duplicate with proper cross connections to permit one filter to be washed with the effluent from another. If filters are located at an elevation higher than the water line of the pool a check valve must be placed on the pump suction.

C. Hair Catcher: The recirculation system should include a strainer to prevent hair, lint, etc., from reaching the filters. The best type of hair catcher consists of a metal chamber containing a removable cylindrical strainer, so arranged that the water passes through the strainer from the outside. The strainer should be of non-corrosive material with openings not more than 1/32 inch across. A slotted strainer is more easily cleaned than one which is perforated. The area of strainer openings should be at least ten times the area of the water inlets. Hair traps should be so constructed that they can be quickly taken down for cleaning by loosening two or three wing-nuts. Proper valves should be provided to prevent flow of water through the strainer while cleaning.

D. Water Heater: In northern climates some method of heating the water is essential for indoor pools. Blowing steam directly into the pool as is practiced in some instances or heating coils placed directly in the pool are not recommended. A heater designed to heat all or a part of the circulation water is preferable. In designing a heater, ample surface for heat interchange must be provided. Such a heater may be designed for use with steam or hot water. Automatic thermal control is desirable. Provision should be made for easy removal of the heater parts for cleaning.

E. Suction Cleaner: In the opinion of the committee the only satisfactory method of removing the dirt, hair, etc., settling on the bottom of a pool is by means of a suction cleaner. As such cleaners are commonly operated by the circulation pumps, they may be classed as an adjunct to the recirculation system. When a suction cleaner is to be operated by the recirculation pump, a gate with graduated stem or other registering device should be provided for throttling the flow from the pool outlet to permit the pump to operate at maximum efficiency when the suction cleaner is in use. Fixed pipe connections for attachment of suction cleaner to pump suction should be of ample size to reduce friction to a minimum and the cleaner and all removable connections should be designed to provide a maximum velocity at the suction nozzle.

F. Piping System: The piping system should be properly designed to reduce friction losses to a minimum. Pipe capacities should generally be at least double the theoretical value. Flange joints or unions should be inserted at intervals to permit any part of the system to be quickly taken down for cleaning or repairs. A sump and blow-off should be provided at the lowest part of the system to permit removal of any accumulating iron rust. Openings should be provided for insertion of gauges to permit vacuum on pump suction and pressure at discharge to be determined, should a study

of the recirculation system be desirable. It is advisable also to make provision for insertion of Pitot tubes or meters for checking the actual volume of water passing through the system under working conditions. Outlets should be provided for obtaining samples of the water as it leaves the pool and after filtration for purposes of laborator tests. Other requirements for piping are discussed under the heading "Inlets and Outlets."

G. Testing the System: After the recirculation system has been installed and the various units tuned up, a test of the hydraulic properties of the entire system and of each integral unit should be made. In such a test the velocity in the piping system at various points, the discharge capacity of each filter and each pump, the velocity and volume of wash water in each filter, and the rate of discharge at each pool inlet should be determined under actual working conditions with the pool at normal working level. The full data of this test should be a matter of permanent record for future comparison. A similar test repeated at least once a year is desirable.

XVI. Proportioning the Water Interchange for Recirculation and Flowing Through Pools

A. In a recirculation or flowing through pool in which the dirty or used water is continually being withdrawn and replaced by fresh or filtered water, purification of the pool water proceeds by consecutive dilution. The first portion withdrawn from the pool will all be dirty water but. owing to the constant admixture of entering clean water with the dirty water remaining in the pool, each succeeding portion of water withdrawn will consist of a decreasing proportion of dirty water mixed with an increasing proportion of clean water. In proportioning the rate at which fresh water should be added to a flowing through pool, or the capacity of pumps, filters, etc., for a recirculation pool, this law must be taken into consideration.

B. Gage and Bidwell have recently worked out the law of purfication by consecutive dilution as applied to recirculation and flowing through pools. The following abstract of a paper in preparation has been arranged by the authors for this report:

It is proposed that the rate of water interchange in a recirculation or flowing through pool be expressed as the ratio of the volume of clean water entering the pool in 24 hours to the total pool volume. For convenience this ratio may be called the "Turnover" rate or "T" of the pool purification system. For example, T=1 when the volume of water recirculated in 24 hours is the same as the pool volume, T=2 when the water circulated in 24 hours is twice the pool volume, etc.

It can readily be demonstrated by computation and by experiment that 7 turnovers are required to effect a removal of 99.9 per cent of the dirt present in the water of the pool when recirculation was started. At the end of the first turnover the purification will be about 63 per cent, after two turnovers about 86 per cent, at the end of three turnovers about 95 per cent, after four turnovers about 98 per cent, after five turnovers 99.3 per cent, and after six turnovers 99.7 per cent. To accomplish a purification of 99.99 per cent 10 turnovers will be required.

If the pool is used regularly by bathers further increments of dirt will be introduced into the water daily, and the removal of each successive daily increment will proceed according to the law. The result of the addition of such daily increments will be an increasing accumulation of dirt in the water up to a certain point, after which the dirt content of the pool water will remain practically constant, subject only to the fluctuations caused by the variations in the daily bathing load. The amount of this accumulation and the time required for the pool water to reach a condition of equilibrium depend upon the rate of turnover of the pool by the flowing through or by the recirculation system, and in the latter system is also dependent upon the efficiency of the filters.

Assuming a daily increment of dirt equal to that in the pool at the start and a filter efficiency of 100-per cent, with a daily turnover (T=1) equilibrium will be reached at the end of the ninth day when the accumulated dirt in the pool will be equivalent to about 58 per cent of the amount present when recirculation and daily bathing was started. With two turnovers per day (T=2) equilibrium will be obtained in four days with a dirt load of about 16 per cent, with T=3 a balanced load of about 5 per cent will be obtained on the third day and with T=4 a balanced load of about 2 per cent will be obtained at the end of the second day. On the other hand, if the recirculation system is so small that it requires two days for each turnover, accumulation of dirt in the pool will con-

tinue for about nineteen days and the dirt load carried in the pool thereafter will be about 155 per cent of the amount present at the start.

It is evident, therefore, that if clean water is to be maintained, the recirculation or flowing through system must be designed to provide a turnover ratio of at least two and that where heavy bathing loads are anticipated, the turnover ratio should be three or more. It is also evident that the recirculation or flowing through system should be kept in operation continuously and that the filters should be operated in the most efficient manner. If the filters have an efficiency of only 50 per cent, or the recirculation system is operated only half the time, the effect will be the same as though the recirculation system were only half the size.

XVII. Filtration

A. Slow sand filters, rapid gravity filters and pressure filters have all been used in swimming pool repurification systems. More than 80 per cent of the recirculation pools in this country are equipped with pressure filters and for indoor pools and small pools where space is limited, this type of filter is to be preferred unless the water is very hard. For large outdoor pools the gravity type rapid filter is suitable and is preferred by some sanitary authorities. Where the water is very hard and cementation of the filter medium is likely to occur the open type of filter is to be preferred. Because of the large amount of space required, and the increased amount of hand labor required in cleaning, slow sand filters are seldom used for swimming pools.

B. Batteries of two or more filters arranged in parallel are preferable to a single unit, in order to permit continuation of filtration and recirculation while one unit is out of operation for cleaning or repairs.

C. Filtering material should consist of at least 36 inches in depth of suitable grades of screened sharp filter sand or crushed quartz and filter gravel. There should be at least 18 inches of freeboard above the surface of the filter material to the overflow troughs or pipes of rapid filters to permit proper washing without loss of filter sand. In some cases filters of bone charcoal, wood charcoal, or similar material have been installed on

swimming pool recirculation systems. When new these materials may have considerable absorptive effect, but after a few weeks' use this power is lost and the filter becomes practically worthless until the filter medium is renewed.

D. In designing a filter system for a swimming pool the rate of slow sand filters should not exceed three million gallons per acre per day, and the rate of rapid filters should not exceed three gallons per minute per square foot of surface area. Automatic rate controllers are essential on slow sand filters. Rate controllers are not usually installed on the rapid filters used for small swimming pools because of the considerable increase in cost. Filters for large pools (100,000 gallons or more) should be equipped with rate controllers and such control is desirable on smaller installations.

- E. Rapid filters of open gravity type must be equipped with loss of head gauges. Pressure filters must be equipped with pressure gauges on the inlet pipe and the outlet pipe for determination of loss of head or back pressure in the filter medium. Pressure filters should have a proper sight glass installed on the waste discharge pipe by which the operator may watch the progress of filter washing. Such glass should be readily removable for When pressure filters are locleaning. cated at an elevation above the water line of the pool each filter must be equipped with an automatic air relief valve. The arrangement and number of valves and interconnecting piping, or "valve nest," for necessary and convenient operation of rapid filters is fairly well standardized, and a discussion thereof may be omitted.

F. Readily removable heads or a large manhole should be provided on pressure filters to facilitate inspection and repairs. Sufficient head room and working space must be allowed about filter units of all types to permit sand replacement and other repairs when necessary.

G. If the water supply contains iron, manganese, turbidity, or any appreciable amount of color, treatment with alum or

other coagulant will be necessary with slow sand filters as well as with filters of the rapid flow type. On filters for pools of more than 50,000 gallons capacity, solution tanks and orifice boxes are to be preferred to the "Alum Pot," so-called, which is usually installed for use with small filters.

H. When the water supply for a pool contains large quantities of calcium bicarbonates, and especially when such water must be heated for use, difficulty is often experienced in maintaining clear water in the pool by the usual methods of coagulation and filtration. To a certain extent this difficulty may be overcome by passing the alum-treated water through a properly designed coagulation and sedimentation basin before filtration. Where the installation of a proper coagulation basin is impracticable it is suggested that water softening apparatus of the zeolite or base exchange type be installed as an adjunct to the recirculation system to permit the calcium content of the pool water to be reduced to a reasonable amount.

XVIII. Disinfection

A. From all available information the addition of chlorine either as a gas or as a water solution by use of proper apparatus is to-day the most satisfactory method of pool disinfection. It is possible not only to completely disinfect the entire body of water in the pool with chlorine, but also maintain in the pool water at all times a residual amount of disinfectant to sterilize immediately any dangerous pollution disseminated by bathers. With the proper chlorine apparatus it is also possible to increase or diminish the dosage as required to compensate for variations in the bathing load. The committee recommends the use of chlorine either as a gas or as a water solution for disinfection of all pools where there is any appreciable bathing load or where bathing suits are worn.

B. A possible objection to the use of chlorine for indoor pools is the chance of

accidental escape of gas into the room. Modern chlorine apparatus is carefully designed and built to prevent possibility of such accidents. As a factor of safety it is advisable to install the chlorinator and tanks in a special closet with vents near the floor connecting with a chimney or other duct leading outside the building.

C. Next to treatment with chlorine as gas or water solution, continuous application of a solution of hypochlorite of lime or hypochlorite of soda is the most effective method of swimming pool disinfection. It is sometimes difficult to handle and apply these chemicals without escape of some objectionable odor into the room. When open to the air these chemicals also change rapidly in chlorine content and frequent tests of the strength of solution being applied and readjustments of the rate of application, as well as frequent tests of the residual chlorine in the pool water, must be made when this method of disinfection is used.

D. Intermittent disinfection with hypochlorites as practiced at many pools must be considered a makeshift. It is possible to obtain satisfactory disinfection by intermittent application of these chemicals and to maintain a satisfactory residual chlorine content in the water when the bathing load is constant and not too high. When the bathing load fluctuates widely the residual chlorine content cannot be adjusted to compensate for these variations, and under excess loads immediate disinfection of infectious matters from bathers may not be accomplished.

E. Sterilization of clear water may be obtained by exposure in thin films to ultra-violet rays. This sterilizing action is confined entirely to the period of such exposure and no residual disinfecting action is carried over into the pool. Disinfection, therefore, proceeds according to the law of purification by consecutive dilution and is subject to the limitations imposed by that law. There is never any disinfectant in the pool water to act on infectious material which may be discharged by bathers during the bathing

period at the time when such material is most dangerous. In a few cases satisfactory control of the bacterial content of pool water has been reported by the use of ultra-violet disinfection alone. In a considerable number of instances, however, it has been found necessary to reinforce or supplement the ultra-violet treatment by treatment with chlorine or hypochlorites. On the basis of any available evidence the committee cannot recommend the use of ultra-violet ray apparatus alone for disinfection of any pool where the bathing load is high or where large temporary loads are likely to occur.

F. Judging from a few reports, a reasonably satisfactory disinfection of water may be accomplished by ozone when the necessary apparatus is properly installed and operated. The data on the use of ozone for swimming pool disin-. fection are very few and inconclusive. There is no evidence that ozone has any residual sterilizing effect after the water has been treated, and disinfection must, therefore, proceed according to the law of consecutive dilution and be subject to all limitations imposed by that law. On the basis of any available evidence, the committee cannot recommend this method for swimming pool disinfection.

G. The committee recommends the use of copper sulphate in combination with either of the approved methods of disinfection at such times and in such amounts as may be necessary to control growths of algae in swimming pools and other bathing waters. The use of copper salts alone as a disinfectant will not produce satisfactory bacterial control and cannot be recommended.

XIX. Diving Towers, Spring Boards and Floats

A. Diving towers, when provided, shall be rigidly constructed and properly anchored to the bottom with sufficient bracing to insure stability under the heaviest possible load.

B. Fixed platforms and floats in the water shall be constructed with an air

space of at least 1 foot beneath. There must be as little under water construction in such platforms as is consistent with strength, and all braces, struts, etc., shall be designed to prevent entanglement or trapping of bathers beneath the platform.

C. At least 12 feet free and unobstructed head room must be provided above diving boards and towers.

D. No diving board or platform more than 10 feet above water level should be permitted at any public place. The elevation of diving boards or towers should not exceed the safe limit for the average swimmer. The consensus of opinion of swimming instructors, etc., as summarized in the Fifth Report of this committee apparently establishes the following as the minimum safe depth of water for diving from various elevations:

Elevation of Diving Platform	Minimum Safe Depth of Water
1 foot	5 feet
3 feet	6 feet
5 feet	7 feet
7 feet	8 feet
10 feet	9 feet

XX. Emergency Equipment

A. Pole hooks, ropes, buoys, and other necessary life saving equipment must be provided and be readily accessible at all pools and bathing beaches.

B. A first aid kit containing aromatic ammonia, tincture of iodine, sterile gauze, absorbent cotton, surgeons' plaster, and bandages of various widths should be provided for emergency use at all public bathing places.

XXI. Suits, Towels and Caps

A. At indoor pools used exclusively by men, nude bathing should be required. At indoor pools used exclusively by women bathing suits should be of the simplest type. Suits when used should be of wool or cotton of simple design and of undyed material or tested for fastness of color. Elaborate suits of varied materials or varied colors should not be permitted.

B. At artificial pools all bathers of both sexes should be required to wear rubber bathing caps.

- C. It is desirable at artificial pools that all suits and towels be supplied and cared for by the management. If individually owned suits are permitted, they should be of prescribed style and material and should be laundered and stored at the pool by the management.
- D. All suits and towels must be washed with soap and boiling water, rinsed, and thoroughly dried each time they are used.
- E. Unless suits and towels are sent to a public laundry, the installation and use of modern laundry equipment at all public bath houses and pools should be required. Cold water washing and air drying should be prohibited. The use of a disinfectant on suits and towels in place of proper laundry methods is a makeshift which should not be permitted.
- F. A sufficient number of suits and towels should be provided to take care of the maximum number of bathers. Unless thoroughly dried by artificial heat in a modern laundry drier, suits and towels should not be re-issued on the same day that they have been used.
- G. Clean suits and towels must be kept strictly separated from those which have been used and unlaundered. Clean suits and towels must not be stored on shelves, handled in baskets or passed out over counters where dirty suits have been.

XXII. Supervision of Bathers

- A. A swimming instructor, bathing master or other qualified attendant should be on duty at the pool side at all times when a pool is open to use by bathers. Such attendant should be in full charge of bathing and have authority to enforce all rules of safety and sanitation.
- B. An attendant should be on duty at the shower room or entrance to the pool to inspect all bathers for skin diseases, open lesions, etc., and to insure that a proper cleansing bath has been taken.
- C. At public bathing beaches one or more life guards should be on duty during all bathing hours.
- D. Swimming pool attendants and life guards should be capable swimmers, com-

- petent in life saving methods and in methods of artificial resuscitation.
- E. No bather should be permitted to enter the pool room or pool enclosure, unless an attendant or other competent person is present. Solo bathing must be absolutely prohibited at all pools.
- F. Whenever a pool is empty, entrance of all persons except pool attendants must be effectually prevented.

XXIII. Personal Regulations

- A. All persons using a swimming pool must be required to take a cleansing shower bath in the nude, using warm water and soap, and thoroughly rinsing off all soap suds, before entering the pool room or enclosure. A bath after donning a bathing suit should not be permitted.
- B. A bather leaving the pool room or enclosure for any reason should take a foot bath before returning. A bather leaving pool to use toilet should be required to take a second cleansing bath before returning.
- C. All bathers should be instructed to use the toilet and particularly to empty the bladder before taking cleansing bath and entering the pool.
- D. Any person having any skin disease, sore or inflamed eyes, cold, nasal or ear discharges, or any communicable disease must be excluded from a public swimming pool.
- E. Persons having any considerable area of exposed sub-epidermal tissue, open blisters, cuts, etc., should be warned that these are likely to become infected and advised not to use the pool.
- F. Spitting, spouting of water, blowing the nose, etc., in the pool should be strictly prohibited. Bathers should be instructed that the scum gutter is provided for expectoration.
- G. All bathers should be instructed that blowing the nose to remove water is likely to force infectious matter into sinus and inner ear cavities and possibly cause serious consequences.
- H. Divers should be advised to wear rubber caps over the ears or to plug the

ears with greased cotton to prevent infection of the ear drum and passages by water forced in by concussion.

- I. No boisterous or rough play, except supervised water sports should be permitted in the pool, on the runways, diving boards, floats, platforms, or in dressing rooms, shower rooms, etc.
- J. Suitable placards embodying the above personal regulations and instructions and those relating to suits and towels should be conspicuously posted in the pool room or enclosure and in the dressing rooms and offices at all swimming pools. At a number of boys' club pools the boys are required to memorize the rules for safety and sanitation as a prerequisite to use of the pool.

XXIV. Chemical and Physical Quality of Swimming Pool Water

- A. Excess Chlorine: Whenever chlorine, calcium hypochlorite or other chlorine compounds are used for swimming pool disinfection, the amount of available or excess chlorine in the water at all times when the pool is in use shall not be less than 0.1 p.p.m. nor more than 0.5 p.p.m.
- B. Acidity-Alkalinity: Whenever alum or sulfate of alumina is used during purification or repurification of swimming pool waters the water at all times when the pool is in use shall show an alkaline reaction.
- C. Clearness: At all times when the pool is in use the water shall be sufficiently clear to permit a black disk 6 inches in diameter on a white field, when placed on the bottom of the pool at the deepest point, to be clearly visible from the side walks of the pool at all distances up to 10 yards measured from a line drawn across the pool through said disk.
- D. Temperatures: The water in any swimming pool should not be artificially heated to a temperature above 72° F. The temperature of the air at any artificially heated swimming pool must not be permitted to become more than 8° F. warmer nor more than 2° F. colder than the water

in the pool at any time when the pool is in use. For best results it is desirable that air temperatures shall be about 5° F. warmer than the pool temperature.

XXV. Bacterial Quality of Swimming Pool Waters

- A. Bacteria Count on Agar—2 Days—20° C. (This count is optional): Not more than 10 per cent of samples covering any considerable period shall contain more than 100 bacteria per c.c. No single sample shall contain more than 200 bacteria per c.c.
- B. Bacteria Count on Agar or Litmus Lactose Agar—24 Hours—37° C.: Not more than 10 per cent of samples covering any considerable period shall contain more than 1000 bacteria per c.c. No single sample contain more than 5000 bacteria per c.c.
- C. B. Coli—Presumptive Test: Not more than two out of five samples collected on the same day, not more than three out of any ten consecutive samples collected on different dates shall show a positive presumptive test.

XXVI. Cleaning Pool

- A. Visible dirt on the bottom of a swimming pool shall not be permitted to remain more than 24 hours.
- B. Any visible scum or floating matters on the surface of a pool shall be removed within 24 hours by flushing or other effective means.

XXVII. Bathing Load Limits

A. Frequency of Changing Water: The total number of bathers using a swimming pool during any period of time shall not exceed 20 persons for each 1,000 gallons of clean water added to the pool during that period. The term "clean water" as used above may be interpreted to mean, new clean water used to refill the pool, new clean water used to replace loss by splashing or during cleaning, water taken from the pool and returned after effective filtration, or any combination of such waters.

B. Frequency of Disinfection: The total number of bathers permitted to use a swimming pool during any period of time shall not exceed 7 persons for each 1,000 gallons of water in the pool unless the pool shall have been completely disinfected at least once during that period. The term "completely disinfected" shall be interpreted to mean that the method of disinfection shall be such as to insure a bacterial quality of water as prescribed under section XXV of these standards.

XXVIII. Operating Control

A. Trained Operators: Each swimming pool should be operated under the close supervision of a well trained operator with common sense and good judgment.

B. Tests for Excess Chlorine: At any pool where chlorine, hypochlorite of lime or other chlorine compound is used for disinfection, the operator must be supplied with a proper outfit for making the ortho-tolidine test for excess chlorine and with permanent standards showing maximum and minimum permissible chlorine in the water. Tests for excess chlorine in the water must be made every day that the pool is in use.

C. Tests for Acidity: At any pool where alum or sulfate of alumina is used or where artificial alkalinity is added to

the water the pool operator must be supplied with a proper outfit for testing for acidity and alkalinity and must make such tests on the water every day that the pool is in use.

D. Operating Records: Every pool operator must be supplied with a proper notebook or with blank forms on which shall be recorded every day the number of persons using the pool, the volume of new water added, the temperature of the water and the temperature of the air. Wherever a pool is used by both males and females the number of each and whether adults or children should also be recorded. At all pools where artificial circulation, filtration, or any chemical treatment is used, a full daily record must also be kept of the actual time pumps and filters are in operation, of the time each filter is washed or cleaned, of the time and amount of each chemical used or added, of the time the bottom and sides of pool are cleaned, and the results of all acidity, alkalinity, and excess chlorine tests.

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This report has been referred to the Council on Standards of the American Public Health Association. The standards herein recommended cannot be considered official standards of the American Public Health Association until approved by the Council on Standards and the Governing Council.

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